10Hz Orbit Feedback

Christoph Montag

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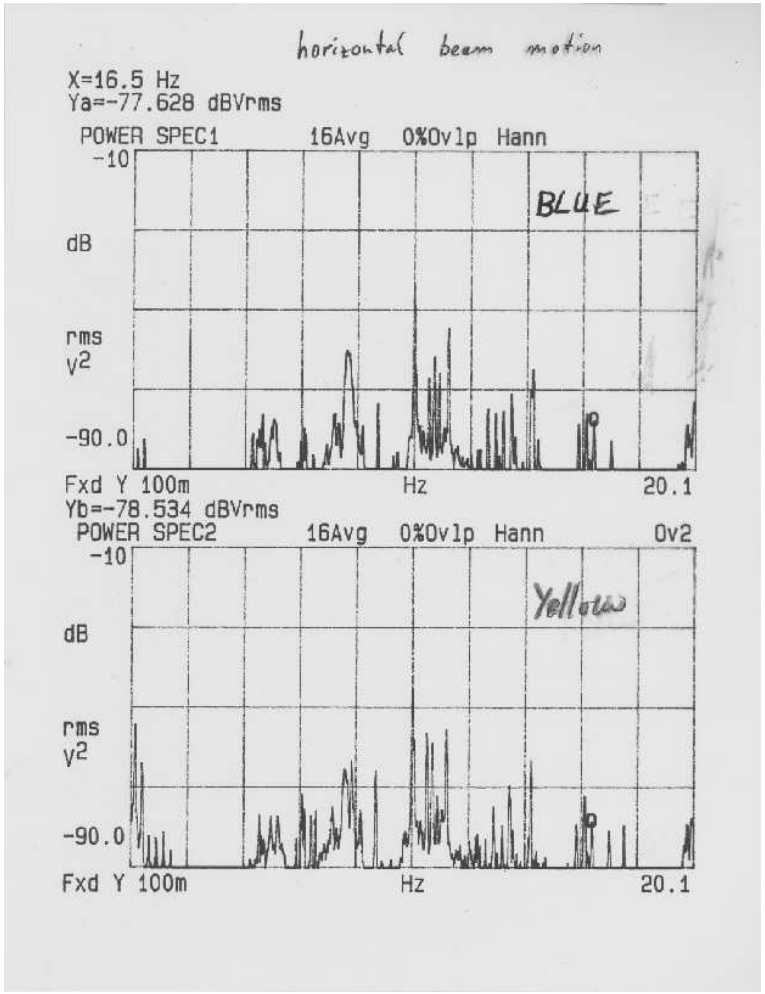
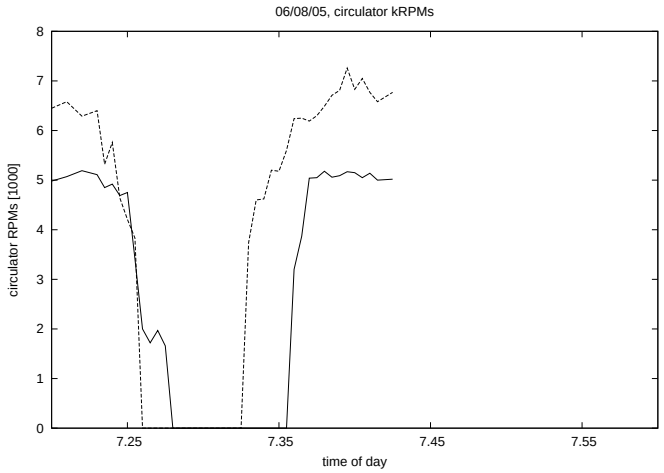
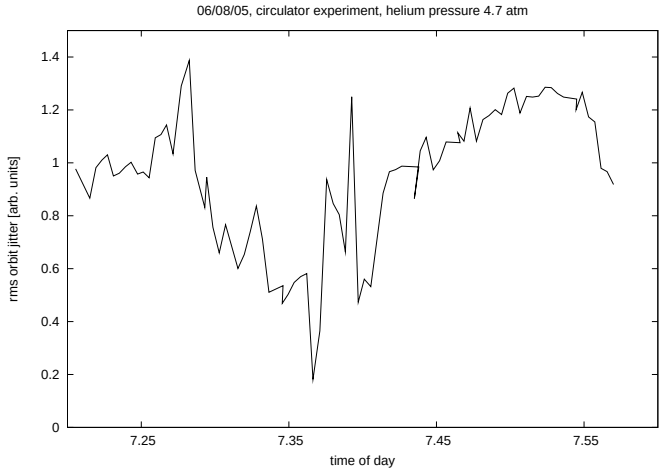
Horizontal beam jitter spectrum, caused by mechanical triplet vibrations due to helium circulator:



Circulator RPMs:



RMS orbit jitter (8.5 - 14.5 Hz):



Orbit jitter leads to modulated beam-beam offsets at the interaction points.

Preliminary results of simulation studies indicate that this causes emittance growth.

This may be the explanation for fast luminosity drop at the beginning of the store.

Something needs to be done to eliminate orbit jitter (at IPs).

Since mechanical stiffening of the triplets turned out to be unfeasible, IR orbit feedback is being attempted.

Orbits are measured by DX BPMs on both sides of each IP; orbits are stabilized by a combination of symmetric and anti-symmetric 4-bumps, thus stabilizing orbit position at IP.

Combination of symmetric and anti-symmetric 4-bumps can equivalently be described as combination of two 3-bumps, each stabilizing the orbit at one DX BPM.

Prototype test: One DX BPM, one 3-bump only

To suppress orbit jitter at the IP by a factor k, orbit jitter at each DX BPM must be suppressed by the same factor k

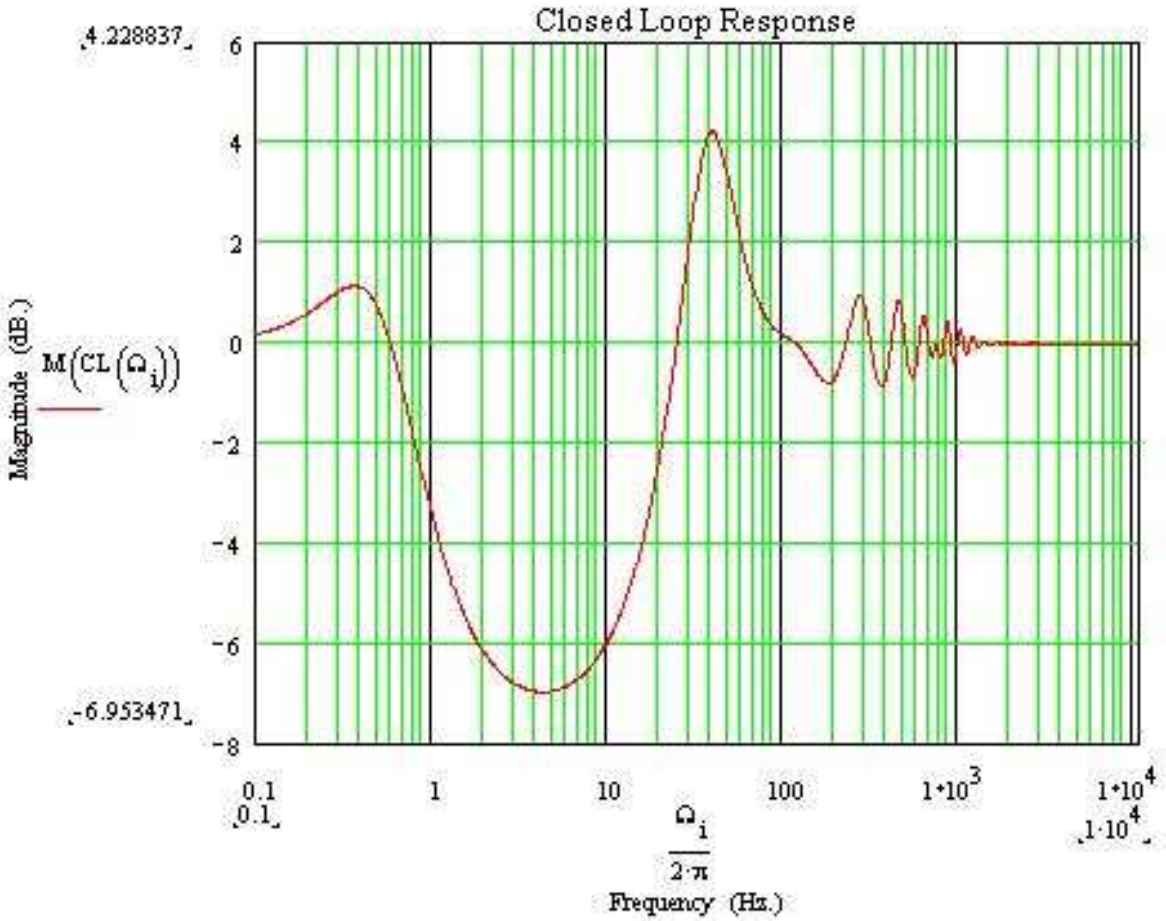
"Large" suppression factor (= "high" feedback gain) required

However, any noise Δx introduced by the feedback on either DX BPM orbit position results in additional offset of $\Delta x/2$ at the IP

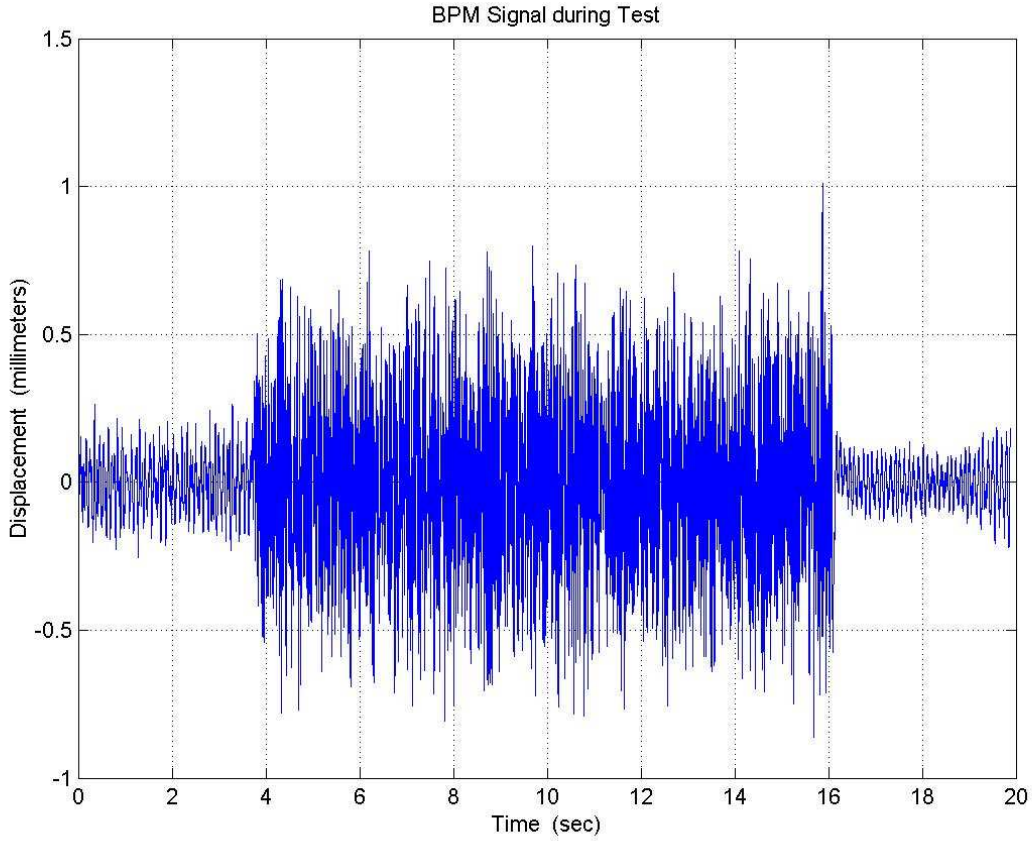
Very good signal-to-noise ratio required

Experimental results

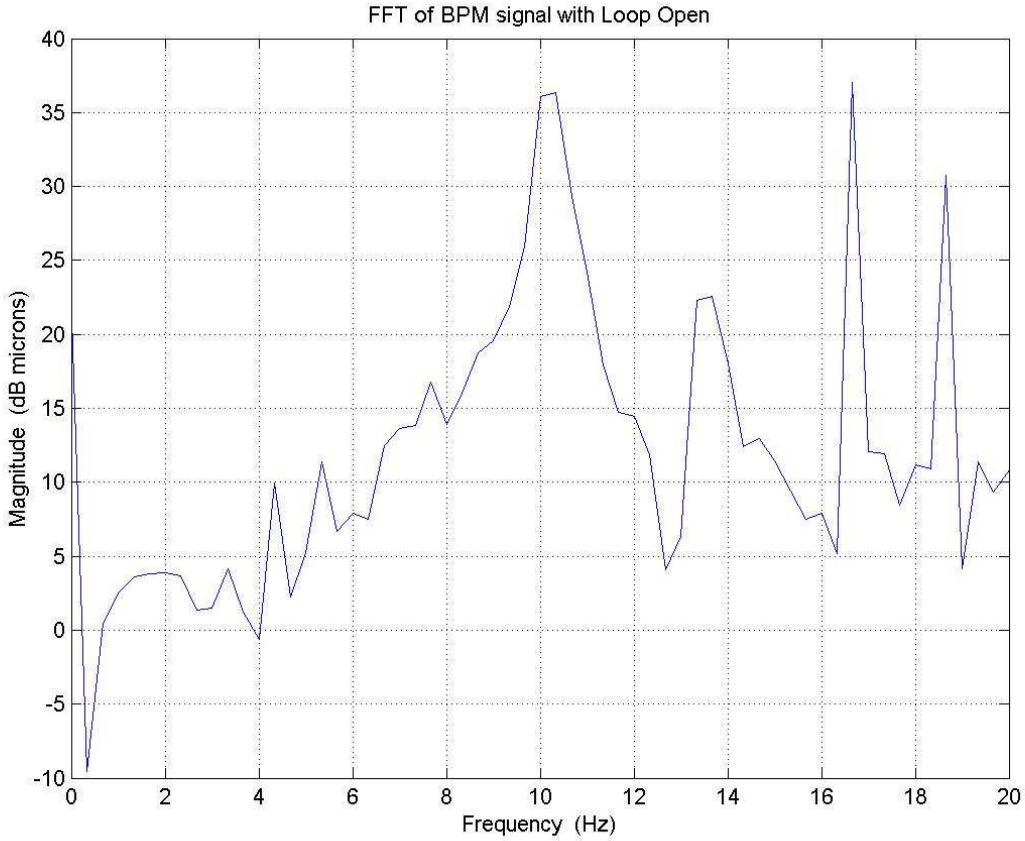
Closed-loop transfer function (model):



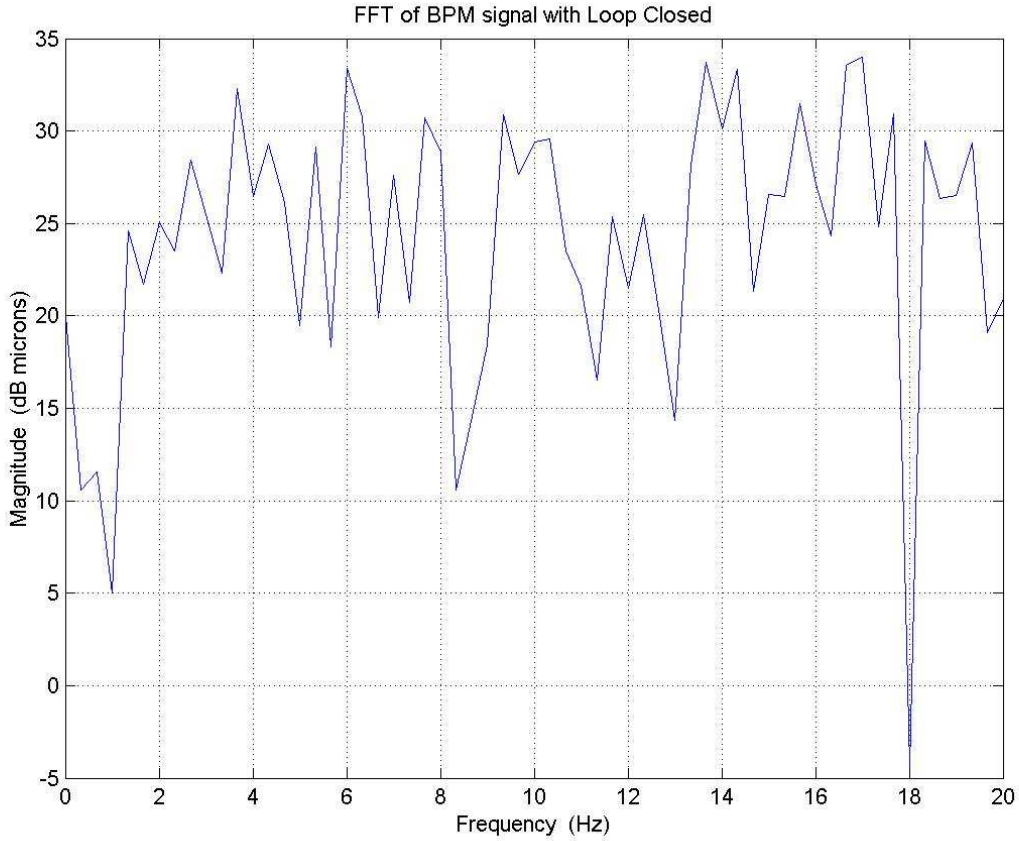
Raw DX BPM signal with feedback on and off:



FFT with feedback OFF:



FFT with feedback ON:

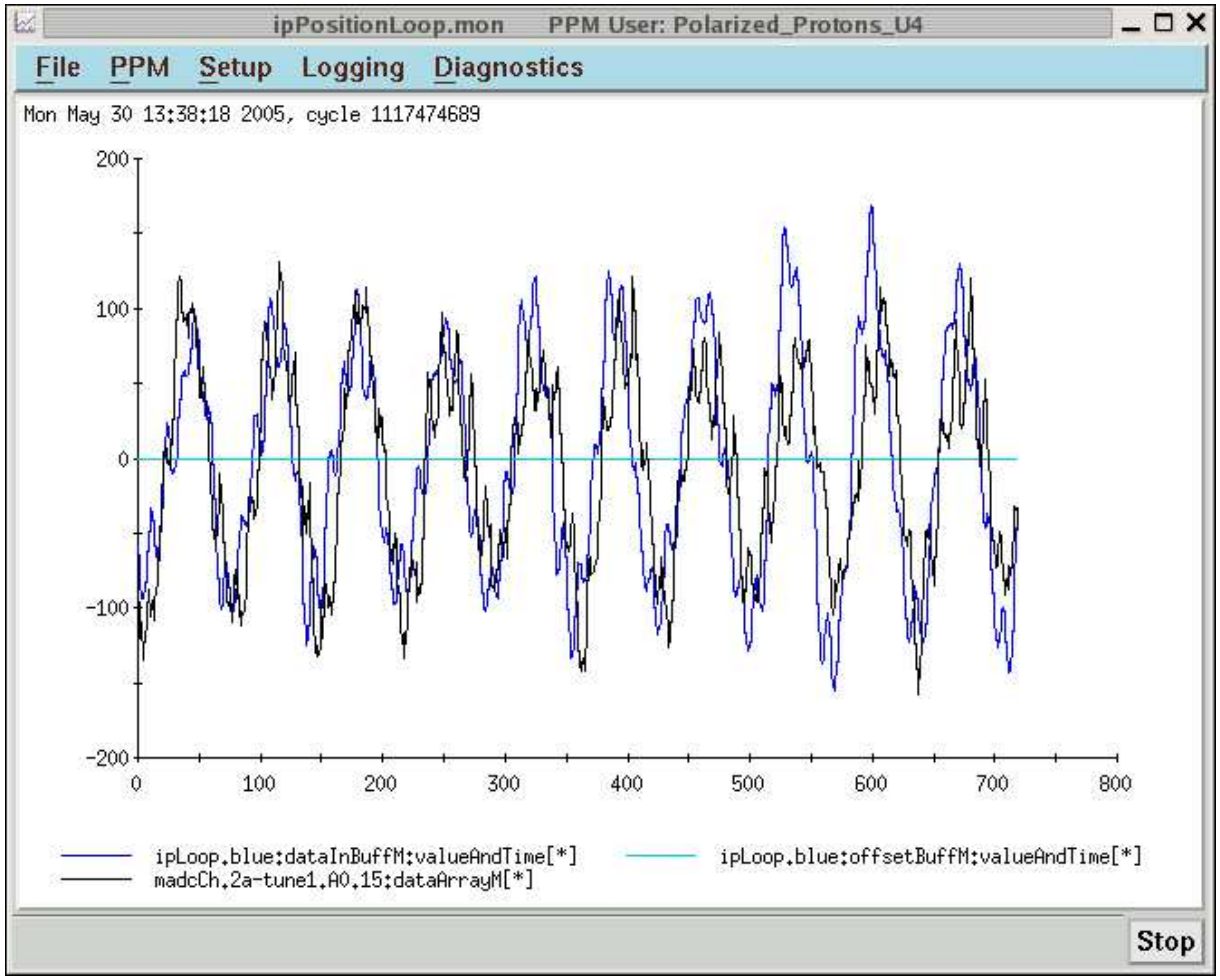


Loop delay of 3/(720 Hz) makes loop design very challenging, since associated phase shift reduces available bandwidth.

720 Hz clock rate (for WFGs) likely causes aliasing effects. The required low-pass anti-aliasing filter causes too much phase shift and would therefore reduce available bandwidth. Simulations of aliasing effect are underway.

Necessary modification: colorred Higher clock rate (5 kHz; A/D conversion already at 22 kHz).

DX BPM signal as seen by the DSP board and the MADC:



A/D converter noise (uncorrelated at the two DX BPMs) would enhance orbit motion at the IP.

When the feedback prototype works, a new low-noise board needs to be designed and built.